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The Future of Small Farms in Asia

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Farms throughout Asia are predominantly small. By nature, small farms use labour-intensive production methods. The question arises as to the viability of small farms in the face of the rapidly increasing wage rate in most Asian countries. There is also indication that the production efficiency of small farms has declined relative to large farms in many other Asian economies, indicating the increasing disadvantage of small farms in Asia. Therefore, this study argues that unless new policy measures are taken to expand farm size, Asia as a whole is likely to lose comparative advantage in agriculture and become an importer of food grains in the future.

Key Words: Small farms, viability, large farms, mechanization, Asia

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1 Introduction

Many studies have found an inverse relationship between farm size and productivity in South Asia, indicating that small farms are more efficient than large farms (for example, Heltberg, 1998; Lipton, 2009). In sub-Saharan Africa, too, the inverse relationship seems to have emerged with the gradual intensification of farming systems (Larson et al., 2014). For commercial crops in Asia, such as sugarcane and pineapples, production has grown faster under the peasant mode of production (for example, Thailand) than under the plantation system (for example, the Philippines), according to Hayami (2001, 2009). Such observations point to small farms' higher production efficiency relative to large farms, even in the production of commercial crops.[1] Furthermore, it is well-known that Green Revolution technology was adopted rapidly by both small and large farmers alike in tropical Asia, which contributed to income growth, poverty reduction, and food security (David and Otsuka, 1994; Pingali et al., 1997; Otsuka et al., 2009). As a consequence, small-scale family farms dominate throughout Asia with very few exceptions. Furthermore, as will be shown later, farm size has been declining in many

[1] Pineapple production in the Philippines has increased faster than in Thailand in recent years, but this could be due to dissolution of plantation which accompanied the contract farming between the plantation owners and former plantation workers.

Asian countries over the last several decades.

It must be pointed out that in order to operate large farms, hired labour must be employed, whereas small farms are mainly rely on family labour. Thus, the lower production efficiency of large-scale farms in Asia can be attributed to the high monitoring cost of hired workers in spatially dispersed agricultural environments (Feder, 1985; Hayami and Otsuka, 1993). The higher production efficiency of small farms, however, does not immediately imply the existence of the inverse relationship between farm size and production efficiency because land markets, if functioning effectively, will reallocate land from large inefficient farms to small efficient farms so as to wipe out the inefficiency associated with farm size. Indeed, in South Asia where land market regulation suppresses rental transactions, the inverse relationship holds (Otsuka, 2007).

The superior performance of small farms in Asia in the past does not guarantee that they will continue to be relatively efficient in the future. Indeed, according to Jha and Rhodes (1999) and Jha et al. (2000), large farms were more productive than small farms in agriculturally advanced regions of India, such as Punjab and Haryana, by the early 1980s. A more recent study by Foster and Rozensweig (2010) also finds that large farms have become more productive than small farms in India with the introduction of farm machinery as a response to rising labour costs. Similarly, in high income economies in

Asia, such as Japan, a positive relationship is found between farm size and productivity (Hayami and Kawagoe, 1989; Otsuka, 2013; 2014a). Inter-country panel-data analyses of the impacts of farm size on productivity by Otsuka et al. (2013) also indicate the growing inefficiency of small farms. Thus, it is likely that larger farms are more efficient than smaller farms in many parts of Asia now.[2]

In order to assess the viability of small farms in future in Asia, this article attempts to identify the determinants of optimum farm size based on a review of the literature, economic theory, and empirical evidence. The basic hypothesis is that the optimum farm size increases with wage rates. Small farms are, out of necessity, labour intensive, particularly subsistence farming in low-wage economies where major staples, such as rice, maize, sorghum, and millet, are grown by using primarily manual methods supplemented by animal traction. The dominance of small-scale farms does not cause any problem of production efficiency in such economies so far as wage rates are low. As the economy develops, however, wage rates increase and the labour-intensive small-scale farming system becomes costly. At this stage, farm size must expand so as to introduce

[2] Large-scale corporate farms have emerged in land-abundant countries in Latin America, Eastern Europe, and Central Asia, where scale economies are observed (Key and Runsten, 1999; Rozelle and Swinnen, 2004; Gorton and Davidova, 2004; Helfand and Levine, 2004; Eastwood, Lipton, and Newell, 2009; Deininger and Byerlee, 2012).

labour-saving production methods, such as using large-scale equipment such as four-whell tractors and combines, in order for agriculture in a high-wage economy to be competitive in international markets.

Farm size, however, does not expand smoothly with economic development in many countries in Asia because of land tenure insecurity and land reform regulations. This is likely to be a serious problem in high-performing and emerging economies in Asia, where farm size has traditionally been small and wage rates have been rising sharply. In this article we would like to argue that small-scale farms in Asia will become increasingly inefficient over time as a production organization in agriculture (Otsuka, 2013).

We show an overview of the farm size and land tenure systems in Asia in Section 2. Then we provide a conceptual framework to explain the changing optimum farm size in Section 3. Next,we examine the increasing inefficiency of small farms in Japan and the increasing dependence upon grain imports in Japan, Taiwan, and Korea in Section 4. Based on our own empirical studies, we discuss emerging changes regarding the advantage of large farms in selected countries in Asia including Indonesia, Vietnam, India and China in Section 5. We demonstrate that migration of the rural labour force to urban and industrialized areas is necessary for farm size expansion in Section 6. We

conclude this article in Section 7 by providing policy implications.

2 An overview of the changing farm size in Asia[3]

Let us briefly review the changing farm size structure in selected countries in Asia (i.e., Bangladesh, India, Indonesia, the Philippines, and Thailand), using agricultural census data from the 1970s, 1990s, and 2000s. Specifically, we would like to examine how the average farm size has been changing and whether the dominance of small farms has been strengthened or weakened over time.

Table 1 demonstrates that small-scale farms make up a major part of the production organization of Asian agriculture. In fact, the average operational farm size was already small in the 1970s, ranging from 1 hectare in Indonesia to 3-4 hectares in the Philippines and Thailand. Furthermore, the average farm size declined in subsequent periods in all five countries. In high-performing Southeast Asian countries, such as Indonesia and Thailand, the reduction in farm size has been relatively modest because the impact of population pressure on limited land has been mitigated by the job creation in nonfarm sectors, which drives the rural labour force away from the farm to nonfarm sectors.

[3] This section draws on Otsuka (2013).

In contrast, the average farm size significantly declined in other economies due to rapid population growth in rural areas. Particularly conspicuous is Bangladesh, where the average farm size declined from 1.4 hectares in 1976/77 to 0.3 hectare in 2005.[4] Large farms above 10 ha are rare in this country, suggesting the absence of scale economies in agriculture. The farm size has also shrunk considerably in India and the Philippines from 1970/71 to the early 2000s. Does this imply that scale advantages are absent in these countries? To our knowledge, farm size is large and expanding in Punjab in India, Central Thailand, and the Mekong Delta in Vietnam where large machineries, such as riding tractors and combine harvesters, have been introduced. Commonly in these regions, the farm size was relatively large from the beginning and, hence, presumably farm size adjustments to increasing optimum farm size would have taken place relatively easily. Thus, even if the average farm size has been decreasing in the country as a whole, we cannot deny the possibility of emerging scale economies in some regions in rapidly growing economies in Asia.

[4] Agricultural landless households are excluded from the estimation of average farm size except in India. In Bangladesh, the average size would be smaller roughly by 10%, if the landless households are included.

3 The economics of farm size

3.1 Land and labour markets in agriculture[5]

Theoretically, it is well known that if the production function is subject to constant returns to scale and if one of the three markets, viz., land rental, land sale, and labour markets, is perfectly competitive, an equally efficient allocation of resources among farming households can be achieved in equilibrium because land-labour ratios will be equalized among farms in all the three cases (Kevane, 1996). In practice, however, it is unlikely that labour markets function efficiently because it is costly to supervise and enforce hired labour in certain c are-intensive tasks in agricultural production.

According to the theory of labour employment in agriculture formulated by Feder (1985) and Eswaran and Kotwal (1986), large farmers employ hired labour because of the limited endowment of family labour relative to owned land. Hired wage labourers, however, do not have strong work incentives, as they receive the same wage regardless of how hard they work.[6] Thus, it is not possible for landowners to enforce their work effort and the care with which they work without undertaking costly

[5] This subsection draws on Otsuka (2014a).

[6] In practice, piece-rate labor contracts (for example, based on area ploughed and amount of products harvested) are common, rather than daily wage contracts, in order to provide work incentives. Piece-rate contracts, however, may induce "quality" shirking, as the quality of work is not properly counted.

supervision.[7] Furthermore, it is likely that the supervision cost of hired labour contracts increases more than proportionally with farm size. To avoid the high monitoring cost of hired labour, some landowners adopt labour-saving or machine-using production methods. Such a technology choice, however, is costly in low-wage economies. Therefore, the high enforcement cost of hired labour will lead to the lower production efficiency of large farms.[8] The theoretical models of Feder (1985) and Eswaran and Kotwal (1986) assume that tenancy does not exist because the landless labourers or near landless farmers do not have sufficient access to credit markets to pay for purchased inputs and, hence, cannot afford to undertake tenant cultivation. In reality, however, landlords often provide credit to their tenants, particularly under share tenancy (Otsuka et al., 1992). Therefore, the imperfection of credit markets alone cannot justify the choice of labour contracts over tenancy contracts.

It must be pointed out that the enforcement or monitoring cost of hired labour is not very high in simple tasks, such as transplanting and harvesting. Since it is easy to observe work effort or to inspect the outcome of work in these tasks, daily-wage labour

[7] The relative flexibility of family labor may also play a role, as it can be mobilized wherever and whenever needed.

[8] Production of large farms is technically inefficient due to high monitoring cost and also allocatively inefficient due to socially excessive use of agricultural machineries.

contracts are widely employed. In contrast, it is costly to monitor hired labour for the tasks that require care and judgment, such as land preparation, fertilizer application, the supervision of a group of hired labourers, and water and pest control in spatially dispersed agricultural environments. Imperfect supervision and labour enforcement in these activities lead to shirking by the hired wage labour, which leads to the inefficiency of large-scale farm operations dependent on hired labour employment. On small farms, these tasks are usually carried out by family labour (Hayami and Otsuka, 1993).[9]

Even if the labour market fails to function, an efficient outcome can be achieved if the land sales market functions well. If the productivity of land is lower on larger farms, there must be agreeable land prices, at which the sellers (i.e., large landowners) and the buyers (small cultivators) can gain through market transactions. It is well known, however, that land sales markets are inactive in many places. To our knowledge, the most plausible explanation for this problem is offered by Binswanger and Rosenzweig (1986) and Binswanger and Elgin (1988), who argue that since land can be used as collateral for obtaining credit, the price of land exceeds the present value of future agricultural profits accrued to land by the amount of benefit accrued from the collateral value. Thus, buyers

[9] The monitoring cost of hired labor may not be very high under highly mechanized systems on large and sometimes super large farms, which prevail in Latin America and Central Asia (Deininger and Byerlee, 2012).

of land cannot cover the cost of land purchases solely from the future agricultural profits. In order for land transactions to take place, buyers must have sufficient funds to purchase land. If the potential buyers are poor small farmers or landless labourers, they may not possess such extra funds.[10]

In fact, tenancy transactions are the most common way of adjusting the allocation of land among rural households with different factor endowments. This can be attributed to the relatively less efficient functioning of land sales and labour market transactions compared to those of land tenancy markets (Skoufias, 1995). This does not imply, however, that there is no transaction cost of land tenancy contracts; on the contrary, search for contracting partners, negotiations of the terms and conditions, their monitoring, and sanctions against breach of contractual agreements all involve some transaction costs. Thus, there are many self-sufficient owner-cultivators who neither rent out nor rent in land (Skoufias, 1995; Holden, Otsuka, and Place, 2009; Holden, Otsuka, and Deininger, 2013). So far as the endowment of owned land relative to family labour is substantially different among farm households, however, resource allocation in the rural economy will be inefficient, unless land tenancy markets function effectively

[10]Land prices may be also higher than justified by their agricultural returns, if people expect land values to rise. Moreover, some farmers see their land as a family heirloom; something to be kept in the family, not to be traded.

(Bliss and Stern, 1982; Sadoulet et al., 2001). In practice in Asia, the majority of farms are owner-cultivated family farms, supplemented by relatively small areas of rented land (Hayami and Otsuka, 1993).

In South Asia, land tenancy is often regulated by land reform laws, which suppress land tenancy transactions. An example is the land-to-the-tiller program in which the owned land in excess of a ceiling is supposed to be transferred from the landowners to the tillers (i.e., tenants), which reduces incentives for landowners to rent out land. As a result, the land allocation is socially inefficient and, hence, the inverse relationship tends to be observed (Holden, Otsuka, and Deininger, 2013). In Southeast Asia, however, land rental markets function more effectively due to the absence of effective land reform programs, except in the Philippines, so that the inverse relationship has seldom been observed (Otsuka, 2007).[11]

3.2 Theory of changing optimum farm size

For simplicity, let us assume that there are only two production modes, i.e., family labour-based small farms and hired labour-based large farms. When wage is sufficiently low, the

[11] A further potential inefficiency of land rentals is that landlord may fear that their tenants will take over their land, perhaps lobbying politically for land redistribution. This fear can restrict land renting and lead to annual rather than long-term tenancies.

labour-intensive, family labour-based cultivation method is cheaper and, hence, more efficient. This is portrayed in Figure 1 by the lower average cost curve of small farms than large farms. Thus, the socially optimum farm output is OA, which corresponds to small-scale farming.

Yet, because of the difficulty in labour supervision and the friction in land markets, the large farmers may adopt labour-saving production methods, even though they are socially less efficient in low-wage economies. If land markets function competitively, however, large farmers will rent out or sell part of their land to small farmers. Due to the rigidity in land markets, inefficient large farms may coexist with efficient small farms. Then, the inverse relationship between farm size and production efficiency (or productivity) will be observed.

Now assume that the wage rate increases substantially relative to machine rental. Then, the optimum production method changes from the labour-intensive to the labour-saving method.[12] Nevertheless, it is uneconomical for small farms to introduce large machinery, which cannot be used efficiently on small farms. Consequently, the average

[12] It is implicitly assumed that agricultural machines are fixed factors of production. Starting with small scale production initially increasing inputs without changing machinery use leads to lower average cost due to scale economies but eventually it leads to higher average cost. In this way, the average cost curve becomes U-shaped, as depicted in Figure 2.

cost of the labour-saving production method becomes lower than that of the labour-intensive production method as is shown in Figure 2. Thus, the optimum farm output increases to OB. If land markets do not function effectively, small inefficient farms and large efficient farms coexist. In consequence, we expect to observe a positive relationship between farm size and production efficiency.

To recapitulate, when the real wage rate is low, the optimum farm size is small and the inverse correlation between farms size and productivity tends to emerge. When the wage rate increases, mechanization will take place to save labour. Because of the complementarity between machines and land, the optimum farm size increases. If farm size adjustments take place smoothly, only efficient large farms survive and no scale economies can actually be observed. In practice, land markets may not function smoothly, so that a positive relationship will arise between farm size and productivity in high-wage economies.

3 Inefficiency of small farms in high-wage economies in Asia

In economies where the wage rate is high relative to the prices of other factor inputs, extensive mechanization becomes profitable, creating scale advantages and hence enlarging the optimum size of farm operation. Yet in Japan the average farm size had

remained at around 1 ha until the 1970s (less than one-tenth of the level in European countries and one-hundredth of that in the United States) despite the remarkable growth in wage rates. Part of the explanation for the dominance of small farms in Japan is likely to lie in the regulation of tenancy markets by land reform laws.

In accordance with the Agricultural Land Law of 1952, the Japanese government purchased 1.7 million hectares of farmland from landlords, which amounted to 80% of the land under tenancy before the land reform, and transferred 1.9 million hectares, including state-owned land, to former tenant farmers (Ogura, 1963). As a result, the ratio of farmland under tenancy declined from 45% in 1945 to 9% in 1955. The Law imposed a very low rent ceiling, thereby further reducing the tenanted area ratio to less than 6% in subsequent years. The law also conferred the strong security of tenancy rights, making it impossible for landlords to evict tenants, and set the maximum landholding at 3 hectares (12 hectares in Hokkaido) to prevent the re-emergence of 'landlordism.' These reforms significantly contributed to the equalization of income and wealth distribution in rural areas.

While the regulation of tenancy transactions prevented the former landlords from re-accumulating land, it also prevented famers who wished to withdraw from farming from renting out land. As the wage rate increased due to the miraculous growth

of the economy from the late 1950s to the early 1970s, the relaxation of tenancy regulation was needed for farm size expansion, but this was recognized only gradually by the government. Despite a series of liberalization measures, the tenancy market has remained relatively inactive. It is often pointed out that farmers are still reluctant to lease out their lands because they lack confidence that they will be able to get them back (Hayami, 1988).

Land reform in Japan did not change the identity of the cultivators of land and, consequently, the distribution of operational landholdings. Thus, the average farm size did not change appreciably from 1960 to l980; it merely increased from 1.0 hectare to 1.2 hectares, despite continuous and rapid increases in wages and substantial progress in mechanization. There is, however, some indication that the shares of both very small farms (less than 0.5 hectares) and relatively large farms (more than 3 hectares) have increased in recent years.

The driving force behind this structural change has been the emergence of scale economies associated with mechanization in the late l960s, including the introduction of riding tractors and combine harvesters. This is illustrated by the revenue and production costs per hectare of rice production by farm size in l960, l975, 1998, and 2008 (Table 2). In 1960, there was no appreciable difference in revenue and costs among farms of

different sizes. Mechanization in this period was characterized by the widespread adoption of threshers and the introduction of small power-tillers. In 1975, however, a significant gap in production costs emerged with mechanization, as reflected in labor and machinery costs in Table 2, which in turn drives up the total cost of rice production per hectare on small farms than on larger ones. This tendency was further strengthened in 1998 - the total cost as well as labour and machinery costs on farms of less than 0.5 hectares was almost twice as high as on farms larger than 5 hectares, even though the revenue per hectare remained largely the same across different farm sizes. Thus, the increased share of large farms in recent years is consistent with the emergence of the scale advantages associated with mechanization in Japan.[13] Yet the question remains as to why small farms continue to be so dominant in Japan.[14]

With the agricultural sector incapable of competing with foreign producers, the Japanese government strictly controls the imports of agricultural products, notably rice, despite increasing pressures for trade liberalization from other countries. If tenancy regulations had been effectively relaxed, farm size in Japan would have been much larger. Accordingly, the efficiency of Japanese agricultural production would have been

[13] Estimation of the translog production function by Kuroda (1987) confirms the emergence of scale economies.

[14] For further discussions on this issue, see Hayami (1988) and Otsuka and Estudillo (2010).

much higher, and agricultural trade liberalization in Japan would not have aroused the fierce opposition from the competent Japanese farmers, who want to expand their farm sizes.

As shown in Figure 3, the grain self-sufficiency ratio in Japan has declined rapidly since 1961, which clearly attests to the sharply declining comparative advantage of agriculture in this country. The self-sufficiency ratios have also declined significantly in both Taiwan and Korea almost in parallel with that of Japan, despite some definitional differences in grain self-sufficiency between the countries.[15] In these countries, farm size has been as small as that in Japan, i.e., around 1.0 hectare, and wage rates have been rising continuously, similar to Japan. There is no doubt that one of the fundamental causes for the lost comparative advantage of agriculture in these three Northeast Asian countries is the preservation of labour-intensive small-scale agriculture in the midst of high and rising wages. Otsuka et al. (2013) confirm this by running a cross-country regression which shows that the self-sufficiency ratio of cereals decreases when GDP per capita exceeds a threshold level in Asia.

[15] Pulses are included in the Taiwan data, whereas coarse grains are included in the Korean data.

4 Emerging advantage of large farms in Asia

While Otsuka et al.'s (2013) study using cross-country data suggests that the advantage of large farms has been increasing in Asia, it is highly desirable to supplement such evidence by micro-level analysis using detailed household data in selected countries in Asia. Hence, based on the results of studies in Indonesia (Yamauchi, 2014), Vietnam (Liu et al., 2013), India (Deininger et al., 2014), and China (Wang et al. , 2201), this section examines the validity of our hypothesis developed in Section 3, which argues that the inefficiency of small farms increases with increases in the wage rate.

Indonesia is an interesting case for the purpose of our study because small farms in Java and relatively large farms in the outer islands coexist (Table 3), so that we can examine the changing advantage of small vs. large farms in the face of increasing wage rates. Even if we exclude the sample of farms which experienced negative income (see the second column), the broad picture of small farms in Java and larger farms in the outer islands remains unchanged. Moreover, it is interesting to observe large variations in real wage growth across major regions (Table 4).

Yamauchi (2014) examines the dynamically changing patterns of land use, capital investments, and real wages by using farm panel data from seven provinces collected in 2007 and 2010. The regression analysis shows that an increase in real wages

has induced the substitution of labour by machines, notably among relatively large farmers. They tend to increase the scale of operation by renting in more land when real wages increase. Machines and land are found to be complementary if the scale of operation is greater than a threshold size. Furthermore, the effect of an increase in farm size on crop productivity becomes positive among relatively large farmers, which is consistent with the machine-land complementarity found among relatively large farmers. Yamauchi (2014) also finds that the above tendancy is even stronger when real wages increase fast. Facing rising labor costs, larger farmers tend to expand their land size and introduce machines, which increases land productivity among relatively large farms, reversing the inverse farm-productivity relationship. Thus, the Indonesian case study clearly supports our hypothesis that the efficiency of large farms increases with increases in the real wage rate.

Liu et al. (2013) uses data from 1992 and 1998 Vietnam Living Standards Surveys (VLSS) and from 2002-2008 Vietnam Household Living Standards Surveys (VHLSS) to investigate machine use and size - productivity relationship from 1990s to 2000s in Vietnam. Descriptive results suggest that tractor rental and labour hiring have become more common from 1992 to 2008, even though tractor ownership has not visibly increased (Figure 4). This is presumably because tractors are owned by wealthy

merchants or business people in rural towns who rent out tractors to farmers. In 2008 more than 60% of farms rented in machines, whereas less than 20% did so in 1992. Such tractorization will increase the relative advantage of large farms. Consistent with such an expectation, the gap in rice yields between small farms with less than 0.6 hectares and other farms with more than 0.6 hectares has narrowed over time and become almost nil in 2008 (Figure 5), which may imply that the inverse correlation prevailed but has largely disappeared in recent years. It is also interesting to observe the rapidly increasing daily wage of manual agricultural labour over the last two decades and its large regional variations (Table 5). It is also noteworthy that farms are small in the north and relatively large in the south in this country (Table 6).

The empirical analyses from Liu et al., 2013 have four main findings. First, large farmers are more likely to use agricultural machines, pointing to the scale economies of machine use. Second, machine use is not responsive to the real agricultural wage in 1992/98 but becomes significantly responsive in 2006/08, suggesting the emergence of clear substitution effects between machine and labour in recent years. Third, the results of the paddy yield regression demonstrate that the inverse relationship between farm size and land productivity holds in the 1990s and in the late 2000s. However, the relationship has significantly lessened: when planting area doubles, the expected paddy yield is

estimated to reduce by 15.6 percentage points in 1990s compared to a reduction of 6.1 percentage points in the late 2000s. Another interesting finding is that the inverse relationship is further lessened or even reversed in areas where farm size is larger and the wage rate is higher. Such a result is in line with our expectation that the inverse relationship weakens with an increase in the real wage rate. This result is also consistent with the observation of Estudillo et al. (2014) that the average farm size among their sample households increased from 1.0 hectare in 1996 to 1.4 hectares in 2009 in the Mekong Delta region.

Using a three-round, nationally representative household survey in India, Deininger et al. (2014) examines the change in the inverse relationship between farm size and land productivity from 1982 to 2008. During this period, the agricultural real wage rose from 20 rupees per day to 47 rupees per day and the inverse size-productivity relationship significantly weakened. Further analyses to explore the mechanism underlying the changing relationship suggest that increases in real wages cause farmers to use more machines but less labor input. Furthermore, larger farmers are more responsive in shifting from labor to machine when wages rise. As is reported by Jha and Rhodes (1999) and Jha et al. (2000), a positive relationship for large farms emerged in the early 1980s in Haryana and Punjab due to mechanization, but not in Madhya Pradesh

where farm size was much smaller. All these findings are consistent with our personal interviews with farmers in Punjab and Odisha in 2013 and 2014 that many labourers have migrated permanently to large cities. They describe labour shortages in rural villages in these states, which induces mechanization to save labour, particularly in Punjab which is more developed than Odisha. It appears that the inverse, neutral, and positive relationships coexist in India, depending on the prevailing farm size, the extent of mechanization, and wage rates.

Deininger et al. (2014) also investigates the performance of labor market and the relative effectiveness of family labor and hired labor in rural India from 1982 to 2008, following Benjamin (1982). The results indicate that market efficiency improves over time and the relative efficiency between family and hired labor decreases as farm size increases in the later period (1999–2008). These findings all contribute to the observed changes in the size-productivity relationship.

Meanwhile, in China, the economy has been rapidly growing over the last three and a half decades, and the wage rate has been rising sharply, particularly since 2003 (Zhang et al., 2011). Thus, the agricultural wage rate or opportunity cost of family labour is also rising and will continue to do so, which makes small farms less efficient as they have been using labor intensive production methods. This also makes it

necessary to increase the operational farm size as well as substitute for labor with machines to save labor costs, which will create scale advantages. Indeed, the use of riding tractors and combine harvesters is becoming common (Yang et al., 2013). Yet the average farm size remained at 0.6 hectares in 2010, increasing only by 0.05 hectares per year since 2000, even though land rental markets have become increasingly active (Kimura et al., 2011; Huang et al., 2012).

It is well-known that the import of soybeans has been rapidly increasing in China, particularly since the late 1990s, which is explained by the increasing demand for livestock feed associated with the shift of diet from grains to livestock products. However, potentially also important is the preservation of small farm size, which would be becoming less efficient if…. It is possible that the production cost of such small farms will increase in the production of all major grains including maize, rice, and wheat, which may lead to an increase in the imports of these grains in the future, as has happened in Japan, Taiwan, and South Korea.[16]

Wang et al. (2014) analyse the dynamics of land transactions, machine investments, and the use of machine services, using farm panel data from China, collected

[16] So far, China has been largely self-sufficient in rice and wheat.

in 5 provinces, i.e., Hebei, Hubei, Liaoning, Shaanxi, Sichuan and Zhejiang, in 2000 and 2008. Their study looks at the effects of non-agricultural and agricultural wage growth, changes in the migration rate, and the proportion of non-agricultural income, all of which are estimated at the village level, on changes in self-cultivated land, rent-in land, machine service used, and machine investments. The results show that an increase in non-agricultural wages, the proportion of non-agricultural income or the migration rate leads to the expansion of the self-cultivated land size. Consistently, the demand for machine services also increased along with increases in agricultural wages and migration rates. This effect is larger for relatively large farms. However, the results on machine investments are not clear possibly because of the development of active machine rental markets (Yang et al., 2013).

Relatively educated farm households respond to the above changes in an opposite way, i.e., decreasing the size of self-cultivated land, possibly by renting it to less-educated households. Since the initial land distribution is relatively equal for historical reasons, it is schooling distribution across households that plays a more important role in separating households into two groups: those who rent in land to expand farm size and those who transition to non-agricultural works and rent out land to others.

Interestingly, the results on crop income equations support complementarities

between rent-in land and machine services (demanded) especially among relatively large holders. This suggests that the possibility of renting in land to expand farm size and the availability of machine service providers or machine rental markets are both critically important in increasing production efficiency. The above findings largely support our main hypothesis that wage growth, which is accelerating as a result of the successful industrialization in China, puts pressure on farmers to substitute labour with machine services as well as expand the size of farm operations to enjoy scale advantages. Thus, in all likelihood, farm size in China must expand, if it wishes to maintain international competitiveness in agriculture.

6 Migration and farm size expansion

Successful farm size expansion must accompany the structural transformation of not only rural economies but also the entire economy, because it requires the large exodus of farm population to rural towns, large cities, and industrial areas through migration. Otherwise, farm area per remaining farm population cannot increase. Already we have seen from Table 1 that the pace of declining farm size is slower in high-performing economies than low-performing economies in Asia because the more rural population was attracted to rapidly growing nonfarm sectors in the former economies. We also found that farm size

expansion is taking place in Punjab in India and the Mekong Delta in Vietnam, where farm population was declining due to outmigration of landless workers and small farmers, who are induced to move to urban areas by increased job opportunities.

Thus, the massive creation of nonfarm jobs to absorb rural population by offering lucrative wages is necessary to realize the significant farm size expansion. The importance of non-agricultural wages to attract rural labour force to nonfarm sectors can be clearly seen in the case of China (Wang et al., 2014), as is shown in Figure 6. In 2000 the relationship between non-agricultural wage and migration rate (i.e., the ratio of the number of migrants to the number of working age rural workers) is not so clear, except for high-wage areas. This is likely because land tenure security was higher and, hence, land renting was more common in more advanced, higher-wage areas, so that farm workers can migrate to other areas by renting out land without fear of losing land rights (Kimura et al., 2011). If tenure security is low, incentives to migrate would be low, because migrants may lose land rights if they rent out their land. Land tenure security improves over time in China and the clearer positive relationship emerged between non-agricultural wage and the migration rate in 2008 in Figure 6. These observations indicate that the development of nonfarm sectors, which provide higher wages, is necessary to attract rural labour force to nonfarm sectors, thereby creating opportunities to expand

farm size by those who continue to work in the farm sector.

What must be emphasized is that the issue of farm size expansion is not simply an "agricultural issue." The farm size expansion becomes important, when the non-agricultural sector grows and its wage rate increases in the first place. In order to expand farm size, farm population must be reduced by rural-to-urban migration. Furthermore, land which used to be cultivated by migrant workers must be either rented out or sold out to the households that continue to be engaged in farming. If the high-performing Asian economies, originally characterized by small farm size, want to maintain comparative advantage in agriculture to the extent possible, the farm size expansion will be indispensable.

7 Concluding Remarks

In the process of economic development in Asia which accompanied the continuous increases in the real wage rate, the comparative advantage of the economy in most Asian countries has been shifting from agriculture to nonagricultural sectors. One reason is the small farm size in Asia, which requires labour-intensive cultivation (Otsuka, 2013). In order to reduce labour cost, farm size expansion and mechanization must take place, as land and machinery are complements. Farm size expansion,

however, is difficult to realize due to the imperfection of land markets (Otsuka, 2007). Also essential for farm size expansion is the migration of rural labour force to urban and industrialized areas.

High income countries in Asia (for example, Japan, Taiwan, and South Korea) have retained small farms and lost their comparative advantage in agriculture, thereby massively importing grains. The question is what will happen to agriculture in other Asian countries if wage rates continue to increase. Since farm size in Chinese agriculture is extremely small and individual land ownership rights are absent, farm size expansion may not take place sufficiently fast. In India, the average farm size is declining and land markets do not seem to function well due to land reform regulations. If China and India, as well as other high-performing and populous Asian countries, such as Vietnam and Indonesia, become major importers of grains in future, world grain prices will rise and poverty is likely to deepen.

In order to prevent such an outcome, new policy measures must be adopted to enlarge the farm size in Asia. Such measures should certainly include the strengthening of land ownership rights and the promotion of land rental transactions. Also needed would be the consolidation of land parcels and the promotion of mechanization to realize scale economies. The evidence reviewed by this study provides a warning regarding the

potentially undesirable impact of preserving small farm size in Asian agriculture on global food security.

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Table 1: Changing distribution of operational farm size in selected countries in Asia

Country	Year of survey	Average operational farm size (ha)	Percentage of farms and farmland			
			Below 1 ha		Above 10 ha	
			Farms	Area	Farms	Area
Bangladesh	1976/77	1.4	49.7	28.8	-	-
	1996	0.5	86.7	42.7	0.1[a]	1.7
	2005	0.3	-	-	-	-
India	1970/71	2.3	50.6	9.0	3.9	30.9

	1990/91	1.6	59.4	15.0	1.7	17.3
	1995/96	1.4	61.6	17.2	1.2	14.8
	2001/03	1.3	62.9	18.7	1.0	13.2
Indonesia	1973	1.0	70.4	30.0	5.9	10.3
	1993	0.9	70.8	29.8	0.2	3.4
	2003	0.8	74.8	-	-	-
Philippines	1971	3.6	13.6	1.9	4.9	33.9
	1991	2.1	36.6	7.3	2.4	23.3
	2002	2.0	40.1	8.3	2.0	20.5
Thailand	1978	3.7	16.4	2.5	6.0	23.6
	1993	3.4	21.5	3.6	4.5	23.2
	2003	3.1	13.1	-	2.1	-

Notes:

Since farm size classes differ from country to country, interpolations were made.

"n.a." means not available.

[a] Farm size above 3 ha in the case of Bangladesh.

Sources: (1) Bangladesh, *Report on the Agricultural Census of Bangladesh, 1977; 1978 Land Occupancy Survey of Bangladesh; Census of Agriculture 1996*. (2) India, *National Sample Survey, No. 215, 26th Round, 1971-72; All India Report on Agricultural Census 1980/71; Agricultural Census 1990-91*. (3) Indonesia, *1973 Agricultural Census*; *1993 Agricultural Census*. (4) Philippines, *1971 Census of Agriculture; 1991 Census of Agriculture*. (5) Thailand, *1978 Agricultural Census Report*; *1993 Agricultural Census*.

Table 2: Comparison of revenue and production costs per hectare of rice production by size of cultivated area (ha) in Japan: 1960, 1975, 1988 and 2008 (average=100)

	Less than 0.5	0.5-1.0	1.0-3.0	Larger than 3.0	Larger than 5.0	Average size
1960						
Revenue	98	97	103	104	n.a.	100
Labor costs	111	105	96	88	n.a.	100
Machinery cost	86	97	106	96	n.a.	100

Total cost	105	102	99	94	n.a.	100
1975						
Revenue	96	97	103	96	91	100
Labor costs	133	114	90	72	67	100
Machinery cost	105	108	99	84	85	100
Total cost	125	109	94	81	80	100
1988						
Revenue	99	99	103	105	91	100
Labor costs	138	114	87	69	63	100
Machinery cost	123	113	92	74	68	100
Total cost	131	111	89	75	69	100
2008						
Revenue	98	97	98	104	101	100
Labor costs	165	127	99	79	67	100
Machinery cost	137	143	94	88	66	100
Total cost	152	132	96	80	71	100

Note: "n.a." means not available.

Source: Ministry of Agriculture, Forestry and Fisheries (Japan), *Survey of Rice Production Costs*, various issues.

Table 3: Average farm size (ha) in Indonesia by region in 2007

	Simple average	Average using only positive crop income in 2007 and 2010

All sample provinces	1.088 (1.429)	1.170 (1.417)
Lampung	1.324 (1.256)	1.342 (1.213)
Central Java	0.366 (0.448)	0.401 (0.535)
East Java	0.519 (1.499)	0.471 (0.410)
NTB	1.005 (1.125)	1.120(1.271)
South Kalimantan	1.249 (1.264)	1.267 (1.024)
South Sulawesi	1.063 (1.068)	1.111 (1.098)
North Sulawesi	1.626 (2.472)	2.201(2.816)

Numbers in parentheses are standard deviations. The second column shows the average farm size of those farm households with positive crop income.

Source: Yamauchi (2014).

Table 4: Real wage growth per year in Indonesia by region in 2007-2010 (%)

	Non-agricultural	Agricultural

All sample provinces	18.32	23.13
Lampung	12.46	51.95
Central Java	6.163	5.733
East Java	27.13	40.02
Nusa TenggaraBarat	24.62	14.71
South Kalimantan	14.43	23.91
South Sulawesi	16.59	-20.70
North Sulawesi	31.22	63.94

Provincial CPI is used for the conversion of nominal into real terms.

Source: Yamauchi (2014).

Table 5: Real daily wage of male agricultural labour (000 VND) by region in Vietnam

	1992	1998	2002	2004	2006	2008
Red River delta	7.49	14.41	13.59	15.28	19.90	28.06
North East	5.16	11.17	11.00	13.00	15.78	22.22
North West	6.96	9.05	9.28	9.38	14.48	18.66
North Central Coast	7.67	12.12	12.96	13.22	19.95	23.58
South Central Coast	7.34	15.56	14.39	16.17	17.60	23.51
Central Highlands	9.21	13.40	13.38	13.89	18.46	26.53
South East	11.44	15.70	17.26	17.14	21.60	25.63
Mekong River delta	15.01	18.69	17.51	19.04	22.41	25.53

Source: Liu, Violette, and Barrett (2013).

Figure 1: Illustration of optimum farm size in low-wage economies

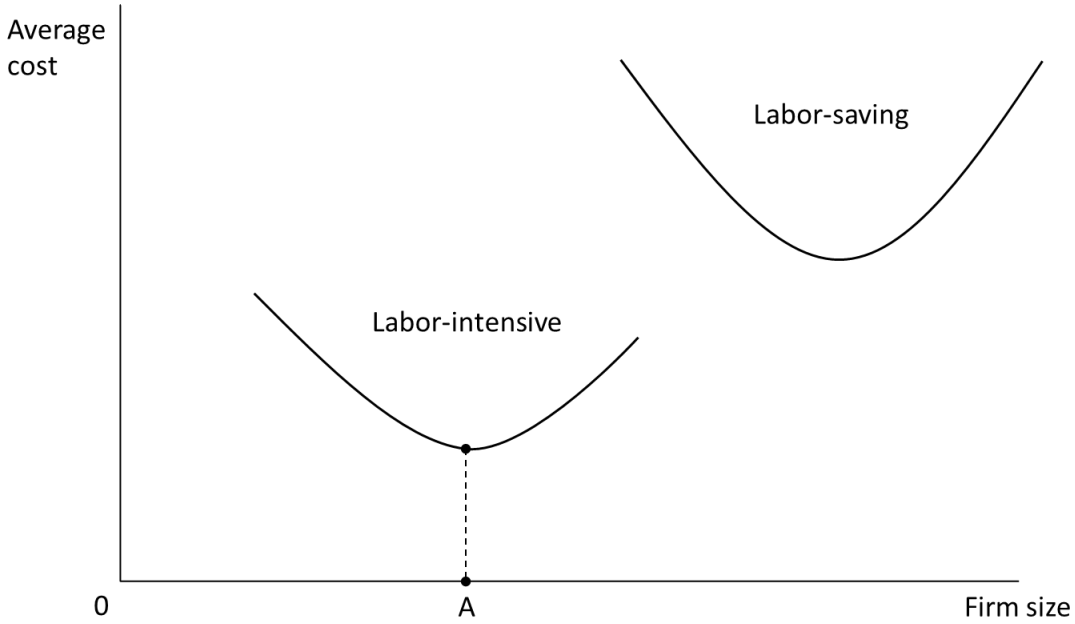


Figure 2: Illustration of optimum farm size in high-wage economies

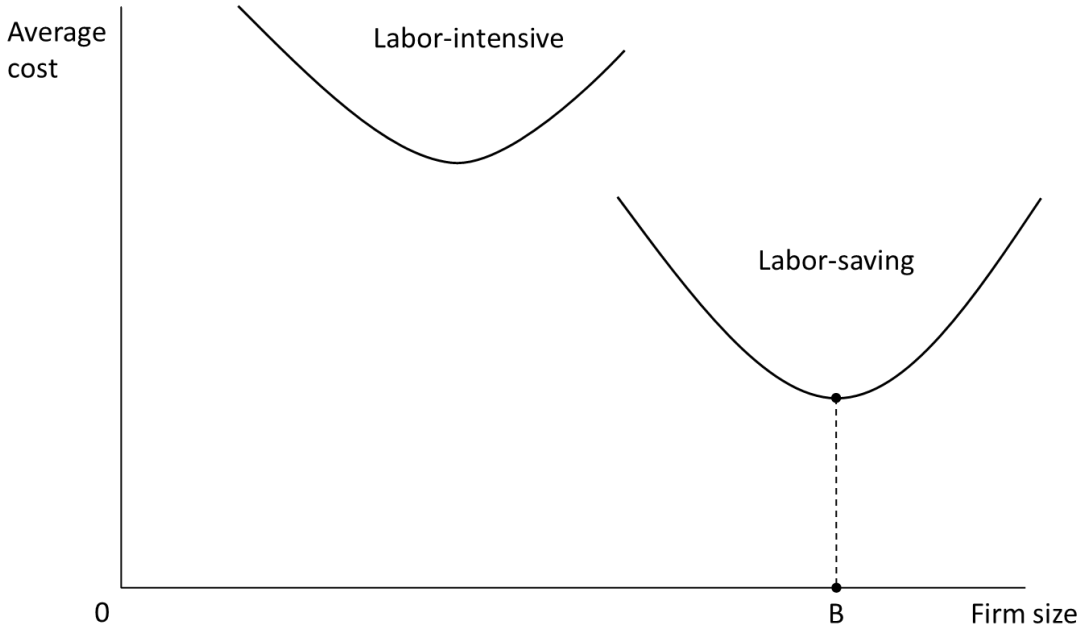
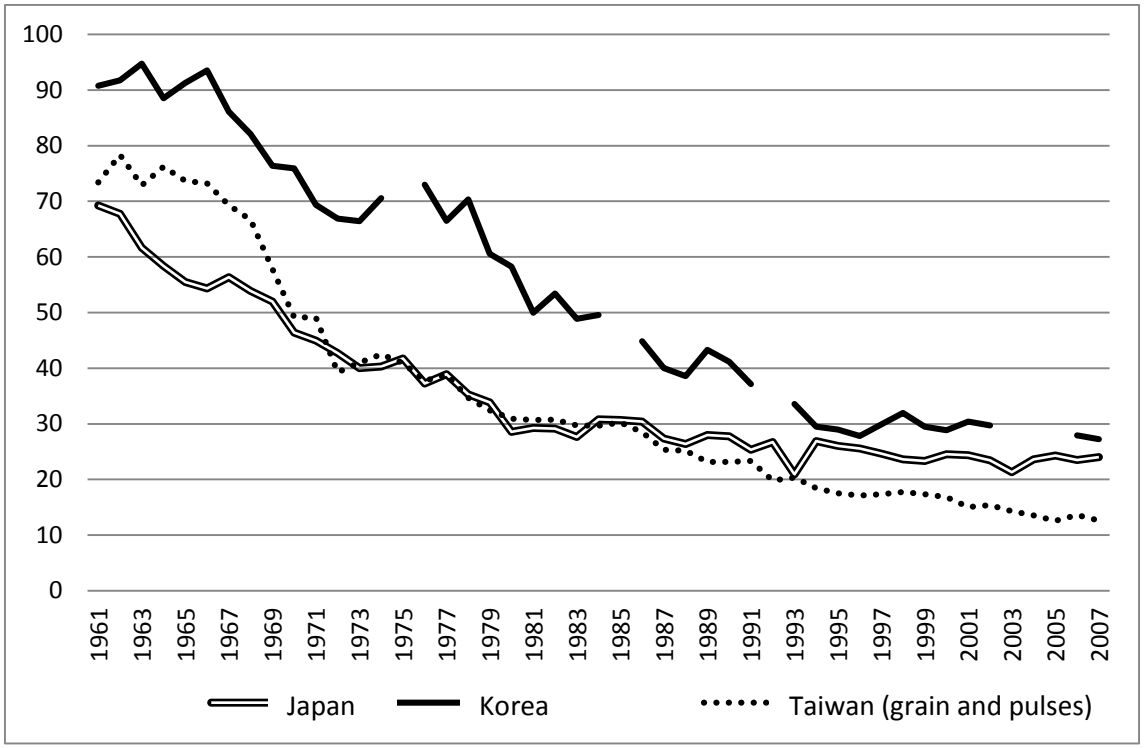


Figure 3: Changes in the grain self-sufficiency ratio in Japan, Taiwan, and Korea.



Sources: *Annual Yearbook* for Korea, *COA Data* for Taiwan, and *FAOstat* for Japan.

Figure 4: Trend of machine ownership, machine renting, labor hiring, 1992-20

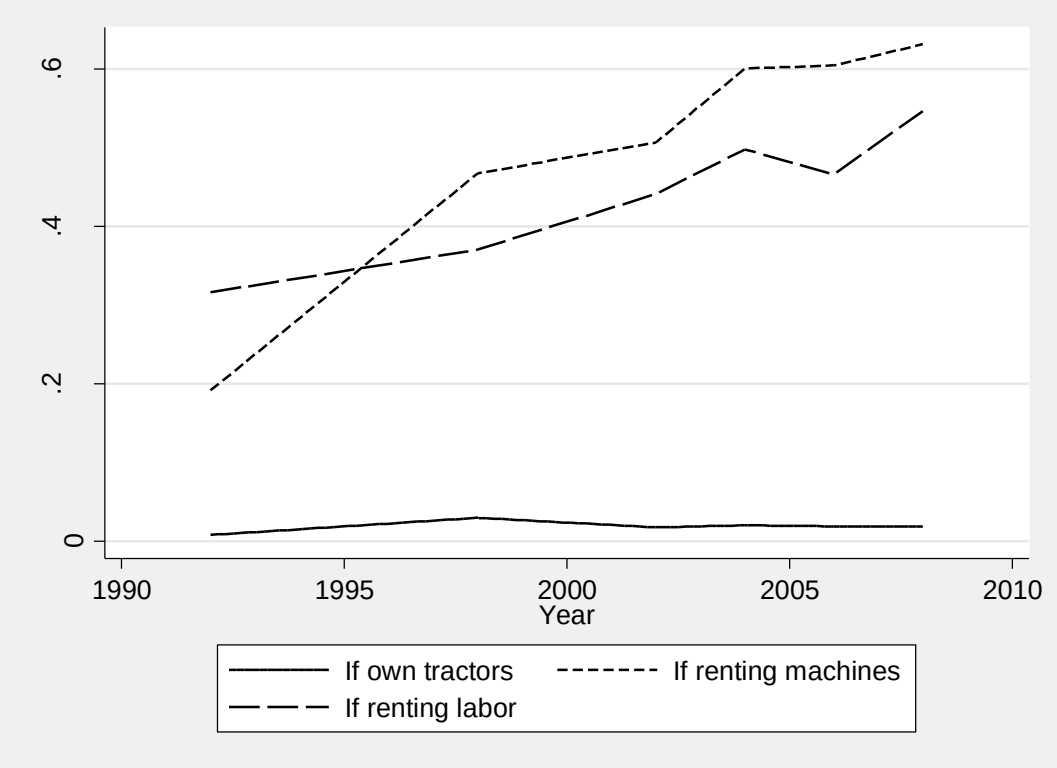


Figure 5: Trend of rice productivity for all farms, larger farms, and smaller farms, 1992-2008

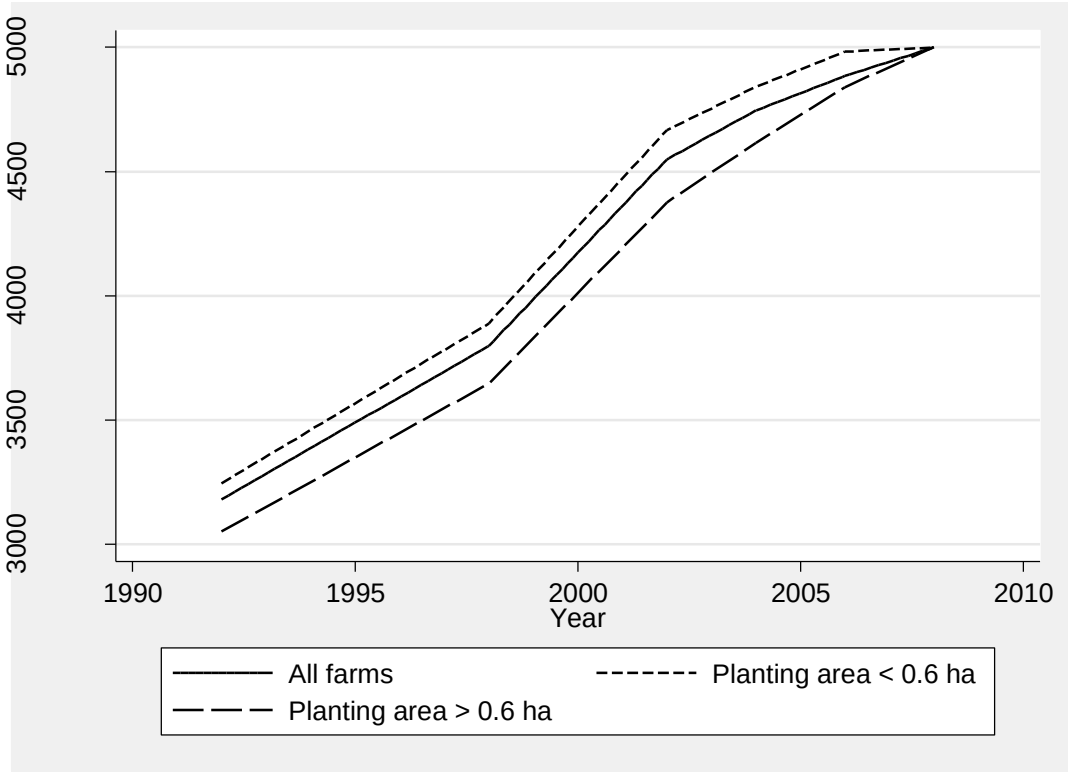
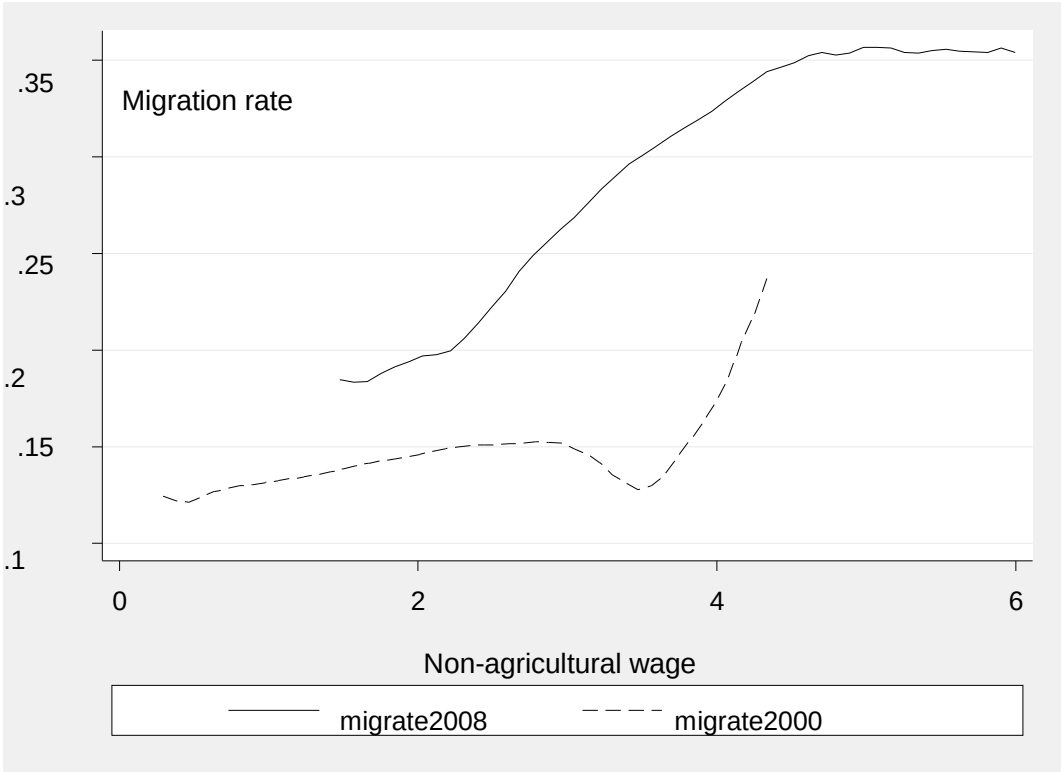


Figure 6: Migration rate and non-agricultural wage in China, 2000 and 2008



Source: Yamauchi et al. (2014).